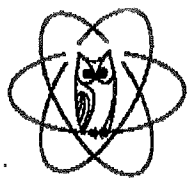
Exhibit 3

Ernest R. Toon
George L. Ellis
Jacob Brodkin

Foundations of Chemistry

CONSULTANTS *MURRAY EHRLICH, formerly Assistant Director of Science, New York City Board of Education.*
ROBERT L. WATSON, Chemistry Coordinator, North Central High School, Indianapolis, Indiana.



Holt, Rinehart and Winston, Inc.
New York • Toronto • London

ERNEST R. TOON, Associate Professor of Chemistry, Los Angeles Valley College, Van Nuys, California.

GEORGE L. ELLIS, Los Angeles City Schools, former Chemistry Instructor, North Hollywood High School, North Hollywood, California.

JACOB BRODKIN, Science Department Chairman, Plainview-Old Bethpage High School, Plainview, New York.

Unit Opening photographs are from the following sources:

Unit 1: *left to right*—Power Authority of the State of New York, Texas Instruments, General Motors Research Labs.

Unit 2: *left to right*—Argonne National Laboratory, Cenco Instruments Corp., Raytheon Co.

Unit 3: *left to right*—General Electric Research Laboratory, Bell Telephone Laboratories, Eastman Kodak, Monsanto Chemical Co.

Unit 4: *left to right*—The Dow Chemical Co., The Hooker Electrochemical Co., United States Steel Corp.

Unit 5: *left to right*—Standard Oil Company of New Jersey, Official U.S. Navy Photograph, Bell Telephone Laboratories, W. R. Grace & Co.

1644756
890123 58 987654321

3

CLASSIFICATION OF MATTER

Preview

Many familiar substances contain more than one kind of matter. Visual inspection of some rock and mineral samples readily reveals the presence of substances having different characteristics. Other objects which on the surface appear to contain only one kind of matter may turn out to be complex mixtures.

Modern analytical techniques enable the chemist to separate and determine the composition of even the most complex mixtures. Classification of the many different kinds of matter into various categories helps to systematize and simplify the study of chemistry. One method of classification is shown in Fig. 3-1.

In this chapter, we will develop and attach meanings to each of the terms and concepts in Fig. 3-1. We will make use of the *Law of Conservation of Matter*, the *Law of Conservation of Energy*, *entropy*, *equilibrium*, and other concepts developed in the preceding chapters. Important new concepts such as *enthalpy* and *periodicity* will be introduced. They should become a part of your working scientific vocabulary. Both will be applied and expanded in subsequent chapters.

Finally, we will introduce the *Periodic Law*, a unifying principle which relates many concepts. This important principle will be widely applied throughout the remainder of the text.

MIXTURES

3-1 Mixtures are combinations of two or more pure substances which retain their identities in the mixture. A mixture may consist of elements, of compounds, or of a combination of elements and compounds. Mixtures are characterized by a variable composition; the individual components may be present in any quantity. For example, alcohol and water may be mixed in any

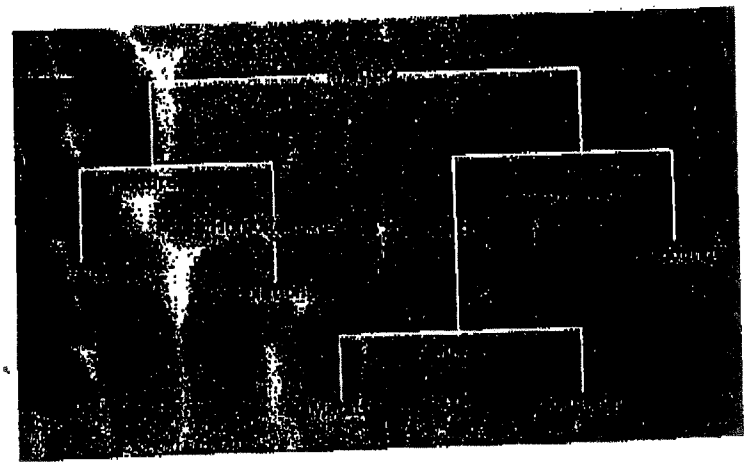


Fig. 3-1 Classification of matter.

ratio to form a mixture. Ordinary rubbing alcohol is a mixture containing 70% alcohol by volume. In contrast to mixtures, ***pure substances*** such as alcohol, water, salt, or sugar have definite compositions.

3-2 **Heterogeneous mixtures such as granite have nonuniform compositions.** The individual components of such mixtures have different properties. Physical examination of a piece of granite reveals that it consists of nonuniformly distributed pieces of quartz, mica, and feldspar. Small crystals of mica are homogeneous pieces of matter and may be physically removed from the heterogeneous granite. Cake mixes, raw milk, and ice cubes floating in water are other examples of heterogeneous mixtures.

Let us make a more detailed examination of a heterogeneous mixture. Consider a glass containing a mixture of ice cubes and liquid water. The mixture in the glass constitutes a system. We will consider three types of systems:

Isolated systems. An ***isolated system*** has a constant amount of mass and energy which cannot be exchanged with any other system. The total mass and energy of the universe is generally considered to be constant. Therefore, the universe is an isolated system.

Closed systems. These systems have constant masses that cannot be exchanged with any other system. However, ***closed systems*** may gain or lose energy. For example, an ordinary thermometer constitutes a closed system. The mercury in the thermometer gains or loses energy as the temperature of the environment changes, but the total mass remains constant.

Open systems. The mass and energy of ***open systems*** may be exchanged with other systems. The ice cube-water mixture men-